Wyoming's

Guidance for Sampling and Analysis Plans

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TABLE OF CONTENTS

Introduction to this Document

A Sampling and Analysis Plan (SAP) is a project-specific brief guide and reference for field personnel, and for data quality assurance/quality control (QA/QC), validation, statistical analyses, and archiving. The approved SAP is good for the life of a project, and does not have to be re-written annually unless there are significant changes. That said, the SAP can and should be a living document that can change as needed while providing samplers and data analysts with enough information to complete project tasks. If specific items (e.g. sites, personnel, parameters) change, an amendment must be provided to all relevant agencies and personnel. Two documents published by WDEQ provide necessary information for surface water sampling in Wyoming: The *Manual of Standard Operating Procedures for Sample Collection and Analysis* (SOP manual, or SOPs), found at http://deq.wyoming.gov/wqd/qaqc/resources/manual/, and *Wyoming's Methods for Determining Surface Water Quality Condition and TMDL Prioritization* (Methodology), found at http://deq.wyoming.gov/wqd/water-quality-assessment/resources/guidance/ . These documents contain the current procedures and WQD/WPP's methodology for collecting surface water quality data in Wyoming. Changes in the SOPs or Methodology must be reviewed when they are issued to see if an amendment or submission of a new SAP might be required.

When determining whether a waterbody is attaining designated uses, Wyoming State Statutes 35-11-103 (c) (xix), and 35-11-302 (b) (i) and (ii), commonly known as the Credible Data Legislation (see below), require Wyoming DEQ to use "*...scientifically valid chemical, physical and biological monitoring data* ***collected under an accepted sampling and analysis plan*** (emphasis added)*, including quality control, quality assurance procedures and available historical data*." As a result of the legislation, conservation districts, local governments, local interest groups, volunteer monitors, individuals and land management organizations that want their water quality monitoring data accepted and used by the Water Quality Division (WQD) Watershed Protection Program (WPP) for designated use support determination must collect that data under an approved SAP. In addition, projects that collect data using federal funding administered through the WQD/WPP (e.g., Section 319 and 205(j) funding), must do so under an approved SAP.

This guide includes the WQD/WPP's requirements for an SAP, with a brief description of each required element.

SAP Required Elements

The elements listed below are required by WQD/WPP for all SAPs accepted by WQD/WPP for designated use support determination or for federally funded Section 319 or 205(j) data collection activities. Inclusion of these elements and accurate implementation of the SAP will help ensure that all QA/QC data review criteria are met when data are submitted to WQD/WPP. The SAP criteria that WQD/WPP will use to review SAPs are provided in a checklist format in Appendix A. An example SAP is provided in Appendix B; this is presented for example purposes only and does not represent a required format.

Title Page

The title page must include:

- SAP Title, Project Name or Sampling Purpose
- Section 319 or 205(j) grant project number (if applicable)
- Date
- Project Officer's name, organization, phone number, e-mail address, and mailing address.

Signature Page

An SAP must have a signature approval page. Required signatures include:

- The Project Coordinator/ Manager or Board Chairman
- All applicable laboratory managers (if the laboratory work is completed by different sections (for example, organic, inorganic) which each have a manager, each manager must sign)
- The primary sampler
- The Wyoming DEQ-WQD Watershed Protection Program SAP reviewer (usually the WQD/WPP Quality Assurance officer)

Introduction

The introduction should **briefly** describe the events or situation which led to water monitoring, the choice of the area to be sampled, the expected timeframe, and the parameters to be measured.

Credible Data Statement

A statement such as, "This SAP fulfills requirements set forth by Wyoming State Statutes 35-11-103 (c) (xix), and 35-11-302 (b) (i) and (ii), commonly known as the Credible Data Law," must be included in the SAP. These statutes are provided below for reference:

> ***§ 35-11-103. Definitions.***
>
> ***(c)*** *Specific definitions applying to water quality:*
>
> ***(xix)*** *"Credible data" means scientifically valid chemical, physical and biological monitoring data collected under an accepted sampling and analysis plan, including quality control, quality assurance procedures and available historical data;*
>
> ***§ 35-11-302. Administrator's authority to recommend standards, rules, regulations or permits.***
>
> ***(b)*** *The administrator, after receiving public comment and after consultation with the advisory board, shall recommend to the director rules, regulations and standards to promote the purposes of this act. The rules, regulations and standards shall prescribe:*
>
> ***(i)*** *A schedule for the use of credible data in designating uses of surface water consistent with the requirements of the Federal Water Pollution Control Act (33 U.S.C. sections 1251 through 1387). The use of credible data shall include consideration of soils, geology, hydrology, geomorphology, climate, stream succession and human influence on the environment. The exception to the use of credible data may be in instances of ephemeral or intermittent water*

bodies where chemical or biological sampling is not practical or feasible;

(ii) *The use of credible data in determining water body's attainment of designated uses. The exception to the use of credible data may be in instances where numeric standards are exceeded or in ephemeral or intermittent water bodies where chemical or biological sampling is not practical or feasible.*

Quality Assurance Project Plan (QAPP)

The QAPP is a critical planning document for any environmental data operation. The QAPP describes how environmental data operations are planned, implemented, documented, and assessed during the life cycle of a program, project, or task.

A QAPP may be developed by the monitoring entity for a project-specific SAP; it must contain all the elements required by the Environmental Protection Agency (EPA). (See EPA's *Guidance for Quality Assurance Project Plans*: http://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf and EPA's *Requirements for Quality Assurance Project Plans*: http://www.epa.gov/sites/production/files/2015-07/documents/r5-final.pdf.) This QAPP must be submitted to WQD/WPP along with the SAP.

Instead of developing a QAPP, reference may be made to the WDEQ/WQD/WPP QAPP, **only if** all aspects of it which pertain to the project will be followed. The WDEQ/WQD/WPP QAPP can be found at: http://deq.wyoming.gov/wqd/qaqc/resources/qapp/.

All samplers must be familiar with the QAPP chosen or developed for use. The ultimate success of an environmental program or project depends on the adequacy and sufficiency of the quality of the environmental data collected and used in decision-making. This may depend significantly on the adequacy of the QAPP and its effective implementation. Quality planning is an absolutely essential component of project management and the QAPP provides the mechanism for documenting the results of the planning process.

Background/Site History

Provide a detailed description of the area and the reasons which led to water monitoring. Describe any previous monitoring efforts.

Purpose and Objectives

Provide a statement of the project purpose, a list of objectives, and questions and issues to be addressed. This element ensures that the participants formulate a clear statement of the project's goals and objectives and understand the purpose of the project and the expected results. The purpose reflects a general statement of the intent of a project and how that project is linked to addressing the environmental problem (or contributing to the field of science). The objectives must be specific and measureable. The project's questions will define what data or information is needed to address the project's goals and objectives.

Study Design

- Describe the project schedule, site locations, resources, possible milestones, and any applicable requirements (e.g. regulatory or contractual requirements). Identifying the available resources and deadlines at the beginning of a project helps ensure the project is feasible and timely. A clear statement of the project's resources, constraints, and deadlines helps prevent potential issues and/or conflicts by determining practical bounds on the project as early as possible. Regulatory, statutory, contractual and other constraints must be considered that might affect the project schedule.

- Identify the type of data needed and how the data will be used to support the project's objectives. Types of, sources for, and how to obtain information needed to address the study questions must be listed. Sources may include literature, existing databases, and/or new data collection. By developing a list of the information needed to address the project questions, the project requirements will be clearly defined. In addition, the list may identify other information that will be helpful, or that can be economically collected to facilitate the use of the project results for other purposes.

  Determine the quantity of data needed and specification of performance criteria for measuring quality. Establishing criteria ensures that the information and products generated meet the objectives of the project. Examples of quality criteria for individual measurements:

  - precision
  - bias
  - accuracy
  - representativeness
  - comparability
  - completeness

- Describe how and where the data will be obtained (including existing data) and identify any constraints on data collection. Describe how to amass the data or information needed for a project by collecting new data, using existing data, citing information from other resources, etc. When collecting new data or information, consider where and when to collect samples (sampling design) to best represent the variable of interest within the sampling unit. Describe questionnaires and survey instruments, sampling technologies, analytical methods, representativeness, etc. When existing data or information (i.e., from models, databases, literature, etc.) is used, consider sources and methods for assembling it. Also consider how the data will be inspected to ensure compatibility with the project's goals and the handling of information/data either through physical custody of samples or the entering of specific information into a database or spreadsheet.

Personnel

Provide the names, applicable training, and experience of the samplers and data interpreters.

Site Location/Permission

Indicate why each site was selected. Provide monitoring site information including Site ID, latitude and longitude, land ownership, and a short narrative of directions to the site. Attach a map showing monitoring sites and other relevant information, and also maps depicting the access routes to each site. Include documentation of permission to sample on private, State, or National Park Service land, and to traverse private or National Park Service land. (The documentation requirement can be satisfied with a written statement that permission has been received.)

Water Quality Parameters

Explain why each parameter was chosen. How will the information be used toward the project's goals/objectives? A table should show each parameter, the measurement units, and the required preservative. This information may be combined with the methods/holding times table (see below).

Field Instruments and Equipment

Include the make, model and serial number of each piece of equipment, who will supply standards and how often they will be replaced, how often calibration will be done, who is responsible for maintenance and how often it will be done, and where the completed log sheets/log books will be archived and for how long. Include a sample of the maintenance and calibration log sheet/book page and the operating/calibration instructions from the owner's manual (or a link to the manual online) in an Appendix.

Sample Duration and Frequency

Including a table showing duration and frequency is probably the simplest way to convey the information. How the table is organized and the table format is project specific; the format should be whatever is most useful to the samplers and/or project manager. This topic should include a short narrative statement which explains whether the sampling is event driven or scheduled, and the reason why the type, frequency and dates were chosen.

Sample Collection and Analytical Methods

This information can be combined into one table which has headings for the parameter, units, method number or name, holding time and preservative; it can also include the Standard Operating Procedure (SOP) name (this must be listed elsewhere in the SAP if it is not included in the table). A list of the preservatives must also be provided; include either here or in the Waste Disposal topic how the preservative will be disposed.

WDEQ SOPs should be referred to by title, page number, and manual year. If an SOP other than WDEQ's is used, a copy must be included in an Appendix to the SAP. (If you choose to incorporate the whole WDEQ SOP manual by reference, be aware you are agreeing to adhere to every procedure in the manual which is pertinent to the project.)

Sample Containers and Labeling

List the source for bottles, if purchased, or identify who will furnish them. Describe how the bottles are known to be free from contamination, how they will be maintained contamination-free, and where the bottles will be stored.

If applicable, contact the contract lab to find out what the lab requires on a sample label, then document the information in the SAP; if site ID and sampler ID are not part of the lab's label requirement, state how the sample will be traced back to the site and the sampler, and how the sample can be related back to the Field Data Log or Field Data Forms such that Chain of Custody is maintained; if the contract lab has no labeling format, minimum required elements would be site ID, date, time, parameter(s) to be tested for, sample number (if multiple samples are taken at one site), and sampler ID (refer to WDEQ SOP for Sample Labeling and SOP for Field Log Books at http://deq.wyoming.gov/wqd/qaqc/resources/manual/). You may draw or paste or tape an actual label on the SAP page so the sampler(s) can see what is required. If sample numbers are written on a Field Data Sheet or Field Log book page, the label contents should allow tracing the sample back to the field information.

Field Notes

Describe the log book format (refer to WDEQ SOP for Field Log Books at http://deq.wyoming.gov/wqd/qaqc/resources/manual/ for required content); if electronic, state platform, application program and version, storage and backup format (disk, tape, hard drive, CD). The Field Log Book and/or Field Data Forms must show the sampler's official initials (refer to WDEQ SOP for Field Log Books for an explanation of official initials). In addition to sampler's name or official initials, be sure to include the collection date, collection time, weather conditions, environmental conditions, any equipment issues, and any modifications made to the SAP or SOP.

Field Data Forms - provide an example; if project monitoring is identical to the *WDEQ Wadeable Streams Assessment Field Data Form* and the sheets from the WDEQ SOP manual are used, they should be included in an Appendix and referenced.

Corrective Action

Compile a list of items which may possibly need modification during the life of the project, then state the action/process for modifying each one, how the samplers will be notified or the SAP modified if necessary, who will implement the action, how the effect of the change will be assessed, and how it will be documented. Items which may need corrective action during the life of the project may include site location, number of samples per site, number or type of quality control (QC) samples, sampling method or SOP, and/or the number of sites. Field personnel are responsible for performing immediate corrective action in the field if a QC issue is found during field QC checks; typically this corrective action will involve instrument maintenance, recalibration, or re-sampling. Field personnel will document this type of corrective action in the field notes. Other corrective actions are the responsibility of the project manager, and, when they involve WQD/WPP monitoring staff, the Monitoring Program Supervisor. Each failure must

be investigated and addressed for the cause of non-compliance if possible (for example, decontamination procedures, inadequate training of staff, improper sample handling). The project manager must address the quality control issue and any actions taken to resolve the matter (re-training of field staff, purchase of new reagent/bottles, replacement of equipment, etc.) must be documented in the project files. The project manager may perform re-sampling and analyses, amend sampling and/or analysis procedures, or accept the data with acknowledgment of the level of uncertainty surrounding the analytical results. The Quality Assurance Officer (QAO) will be notified for any systemic problems unable to be addressed by the project manager alone.

Safety

Describe all safety measures and precautions; refer to WDEQ's SOP for Safety and Safety Equipment. If the project sponsor will be buying and storing chemicals, a statement about Material Safety Data Sheets (MSDS) being available in the office, where they are and that the samplers will be given that information must be included in this topic. This topic should be as detailed as necessary to ensure the safety of all field personnel; may include name, address and telephone number of nearest hospital; how samplers may get basic first aid training if they want it; and if the samplers are required to carry a cell phone as a safety measure. **It is strongly recommended that no sampler should go into the field alone. Sampling should not be done if flows are too high and strong for wading unless some other method is devised.**

Laboratory

List name, address, phone, contact person and what test(s) will be performed for each contract lab used for the project; state whether the laboratory QAPP has been reviewed by the Project Manager/Coordinator and whether a copy is in the project office.

Quality Assurance/Quality Control (QA/QC) Activities

- QA/QC measures must be identified and described in the SAP. The following QA/QC elements are required:

Chain of Custody

Describe the project Chain of Custody (refer to WDEQ's SOP for Chain of Custody), found at http://deq.wyoming.gov/wqd/qaqc/resources/manual/ and include examples of all Chain of Custody forms; state where, by whom and for how long the completed forms will be archived. Some laboratories furnish a Chain of Custody form; a blank copy should be included in the SAP Appendices and a copy of the completed form should be returned to the Project Manager/Coordinator by the lab and be made a permanent part of the project file.

Data Quality Objectives (DQOs)

The ultimate goal of WQD/WPP water quality monitoring programs is to provide data of the appropriate type, quality, and quantity for the Program's decision-making and assessment purposes, compliance functions, and other project-specific goals. The DQO process is used to develop performance and acceptance criteria that clarify study objectives, define the

appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Many WQD/WPP programs have similar DQOs because project objectives are based on whether or not measured parameters/constituents attain Wyoming's water quality standards. For these standards, refer to Chapter 1 of the Wyoming Water Quality Rules and Regulations, found at http://soswy.state.wy.us/Rules/default.aspx. However, some WQD/WPP projects/programs also have project-specific DQOs that must be included in project-specific SAPs. Each project manager can develop DQOs for their programs/projects and is encouraged to do so following EPA's *Guidance on Systematic Planning Using the Data Quality Objective Process*, found at http://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf.

All environmental data collected by and for the Program must meet the minimum requirements discussed in the following sections.

Blanks, Duplicates, and Spikes

Describe the number or percent of duplicates/blanks/spikes (quality control samples) to be collected; how the collection frequency was chosen; and how the locations are chosen. Quality control samples are used to estimate the precision, representativeness, and accuracy/bias of field activities or field plus lab activities. At a minimum, the following quality control samples must be collected at the frequency described below. Field quality control samples will be prepared in accordance with WQD/WPP SOPs, and labeled, documented, handled, and analyzed the same as regular samples. Field and/or equipment blank samples are primarily applied to chemistry samples and are inappropriate or unnecessary for some types of biological samples. This should be noted in WQD/WPP's SOPs and project-specific SAPs.

Blanks

- (For *Escherichia coli (E. coli)*) One field blank must be prepared, using analyte-free water (sterile reagent water or deionized (DI) water), for each cooler used to transport samples collected during a sampling trip. A minimum of one laboratory blank, using analyte-free water, must be prepared for each sample test run or uninterrupted series of analyses. (A test run is defined as either an individual or group of samples prepared and incubated as one lot during an uninterrupted time period.)

  When only one site is sampled in a day AND the sample and duplicate are sealed and the incubation process is initiated at that site, a lab blank is the only blank required.

- (For all other analytes) A minimum of 10% of the samples collected by one sampling crew in one sampling season must be a field or trip blank.

Field blanks are used to assess potential sample contamination due to sample bottles, preservative, ambient site conditions, or cross-contamination during transport. Sample bottles must be filled with analyte-free water, and handled in the same manner as other samples.

Bottles containing preservative are not to be rinsed. Unpreserved bottles must be triple-rinsed with analyte-free water before filling. Trip blanks are prepared by the laboratory or field staff using analyte-free water, transported to the field, and handled in the same manner as other samples; they are not to be opened in the field.

- **Performance Goal: attain results below the reporting limit**

Duplicates

- (For E. coli) One duplicate/replicate sample per 10 samples collected, or one per sampling trip if less than 10 samples are collected.

- (For all other analytes) A minimum of 10% of the samples collected by one sampling crew in one sampling season must be a duplicate/replicate sample.

- **Performance Goal: attain results which are less than the Relative Percent Difference (RPD) listed in Table 3 below or the project-specific SAP**

Other

There are other optional field quality control samples such as field split samples to assess accuracy and comparability of results between two analytical methods or laboratories, and field matrix spikes to determine the effect of the sample preservation, shipment, storage, and preparation on analyte recovery efficiency for a given matrix. Project-specific SAPs may specify a higher frequency of quality control sample collection than listed above.

Accuracy

Accuracy is a measure of the overall agreement of a measurement to a known value such as a reference or standard. It includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations. Laboratories test their instruments with reference materials to ensure accurate results and analyze spiked matrix samples to assess accuracy (expressed as percent recovery). Lab splits (split a sample in the field and submit both subsamples for analysis to two different laboratories using identical analytical methods) can also address accuracy, precision, and bias between labs. Field instruments are calibrated, maintained, and checked against standard reference materials (SRMs) to ensure accurate measurement of water quality parameters. Additionally, accuracy is improved in the field through the use of and adherence to SOPs. A routine goal for laboratory accuracy for water samples is 85%-115%, but will depend on the analytical method and matrix interferences.

Precision

Precision is the measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions; expressed as the RPD. Overall precision for sampling and analysis is assessed via field duplicates/replicates – co-located simultaneous or

consecutive samples are collected, processed, and analyzed to obtain information on sample acquisition, handling, shipping, storage preparation, and analytical processes and measurements. Additionally, laboratories perform their own replicate analyses, initial precision and recovery samples, and matrix spike/matrix spike duplicates to assess laboratory analytical precision. In the field, precision is maximized (variability is reduced) through strict adherence to SOPs for sampling methods and sample handling.

Water Chemistry and Field Parameters

Table 3. Water Chemistry and Field Parameter Precision Goals Relative Percent Difference (RPD) for selected parameters (*see Appendix C in the current WQD/WPP SOP Manual for analysis and calculations, including Reporting Limit (RL) ranges*. The manual can be found at: http://deq.wyoming.gov/wqd/qaqc/resources/manual/)

Reporting Limit (RL) Range	Sulfate, Alkalinity, Total Suspended Solids (TSS) & Turbidity	Hardness & Chloride	Nitrate-Nitrite	Total Phosphorus & Total Nitrogen	Chlorophyll a	All Other Water Chemistry Parameters with Reporting Limits		Temperature, Conductance, & Dissolved Oxygen (DO)	pH
RL < 3X RL	None	None	None	None	None	20%		10%	+/- 0.3 S.U.
3X RL < 10X RL	None	None	20%	30%	None	20%			
≥ 10X RL	20%	10%	20%	20%	30%	20%			

Macroinvertebrate samples

Precision for macroinvertebrate samples indicates the degree of agreement between simultaneous, and immediately adjacent, independent samples. Field duplicates are used to indicate the amount of variability in the data due to sampler collection techniques and training. Field sampling precision of a macroinvertebrate data set requires field duplicate samples collected independently by different samplers working simultaneously at the same site. The minimum number of duplicate samples per field office per season is 10% of the total macroinvertebrate samples collected. Duplicates must be collected on an ongoing basis during the field season.

Macroinvertebrate sample precision is calculated for total abundance (number/square meter) and total number of taxa. The precision requirement for total abundance is ±50% and for total number of taxa it is ±15%. The precision measurement is calculated using the RPD between duplicate sample results per each parameter.

E. coli *samples*

Precision indicates the degree of agreement between sequential independent samples at a site, collected by applying the same collection method. The minimum number of duplicate samples is 10% of the samples collected per day and at least one duplicate per sampling day when less than 10 samples are collected.

E. coli duplicate precision is calculated for the number of Colony Forming Units (CFU) per 100 ml value and is set at ±50%. The precision measurement is calculated using the RPD between duplicate sample results of the same aliquot. For Most Probable Number (MPN) results less than 100 CFU, no RPD limit is required.

Field Audits

The monitoring entity may elect to have an independent party complete a field audit. In these instances, the WQD/WPP QA/QC officer will review any report provided, for additional insight or information pertinent to the QA/QC Data Review.

The qualifications of the independent auditor should be consistent with the training and experience required of an individual sampler. The monitoring entity must be available for a field audit conducted by the WDEQ; this must be stated in the SAP. Suitable notice and mutually agreeable arrangements will be made if such an audit is scheduled.

Analysis

Describe how the acquired data will be analyzed (either in the field or the laboratory), evaluated (i.e., QA/QC review, verification, validation), and assessed against its intended use and the DQOs. This element focuses on the reviews of both the information (such as verification and validation) and the project. It is important to determine up front how data and information will be summarized, displayed and communicated, how uncertainty in the information will be determined and accounted for in the final product, and how the information will be used to achieve the project's goals.

Analytical Procedures

These descriptions may be narrative or in table format. Describe the method(s) to be used. The USDA-NRCS National Handbook of Water Quality Monitoring (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044775.pdf) may provide some examples and applications. If an electronic method is used, show platform, application program, storage and backup format (disk, tape, CD, hard drive) to be used. Describe how test result values of zero or "Below Reporting Limit" will be handled in the analyses. Analytical methods should be selected that provide comparable, sensitive, and accurate data for the sample matrix and range of expected values for the constituents being analyzed. For water chemistry analysis, it is important that reporting limits be at or below numeric water quality criteria. Whenever possible, approved and published methods from EPA or another accepted entity (such as United States Geological Survey (USGS), Standard Methods, or American Society for Testing and Materials (ASTM)) will be used. Each laboratory utilized must have documented analytical method protocols available for review. Routinely-used analytical methods are also described in many WQD/WPP SOPs for sample collection. All project-specific SAPs must list all analytical methods per matrix for the program/project. When analytical failures occur, whether recognized by the project manager or by WQD/WPP's QAO, the issue should be addressed with the analyzing laboratory to remedy the error/issue.

Reconciliation with DQOs

DQOs for each program/project must be clearly defined and documented. An evaluation of the usability and limitations of all data collected and validated, with respect to the DQOs, must be documented after completion of data collection activities, or for ongoing projects.

Evaluation of Data

A description of the evaluation of data with historical or expected data must be included.

Data Verification and Validation

Data verification is done before data validation, and before any data are used for project/program decision-making.

Data Verification

Data verification demonstrates that a data set meets a specified set of criteria which is described in the project SAP, and that data comply with the Credible Data Legislation. Data verification is performed initially by the personnel who collected the data and is spot checked by their supervisor(s). This systematic process evaluates data collection performance and compliance against a set of project standards for completeness, correctness, and consistency. Refer to WDEQ's SOP on Data Verification found online at: http://deq.wyoming.gov/wqd/qaqc/resources/manual/

Data Validation

Data validation is performed by the QA Officer, another qualified responsible party, or persons under their supervision, after data verification is complete. Data validation results in data of a known, identified and defensible analytical and sampling quality. Data cannot be used for Watershed Protection Program decision-making until after the data validation process is completed.

Data validation does not make determinations about the overall usability of the data for a specific project. Only the end user (internal or external) can make that decision, based on the documented measurement error and sampling variability of the data set of interest. The purpose of data validation is to demonstrate, by using a documented systematic set of assessment criteria, that a data set meets project monitoring requirements, and that data comply with the Monitoring QAPP and the Credible Data Legislation.

Data validation is the process which determines whether data collection quality control (QC) objectives were met. The end result of the data validation process for each data set is a decision to accept the data unconditionally, to qualify all or part of the data set, or to reject all or part of it. Data which are rejected cannot be used at all. Data which may or may not be useable are qualified, and the reasons for the qualification are given so that data set users can evaluate its suitability.

Data Archival

Describe how, where and by whom the data and all paperwork (maps, charts, equipment logs, field logs, monitoring forms, chain of custody forms, permission letters, etc.) associated with the sampling will be archived and for how long; if the project sponsor anticipates that the data might ever be submitted in any kind of regulatory or enforcement action, all project materials should be permanently archived.

Reports

The project-specific SAP should identify the authorship, recipient, contents, frequency, and distribution of reports issued to inform management or WQD/WPP of project status and QA issues. Projects of a short duration may have only one final report. Ongoing monitoring projects may have regular reporting such as quarterly or semi-annual reports. If stated in the SAP, the project manager will analyze data against water quality standards on a regular basis per project-specific requirements. If reports reveal data quality issues or identify that DQOs are not being met, the project manager will make the appropriate changes to improve quality

QA/QC Report

The monitoring entity may elect to have an independent party complete a project QA/QC report. In these instances, the DEQ QA/QC officer will review that report. If the monitoring entity does not elect to have the independent QA/QC report done, the DEQ QA/QC Officer will conduct this review on the raw data and final report. The final report must contain a summary of the QA/QC activities.

References (for an SAP)

Include references to any publications used in developing the SAP.

Appendices (for an SAP)

Appendices should include maps, blank copies of forms which will be used, examples of labeling, equipment manuals (either in hard copy or links to online manuals), internal QAPPs, laboratory QAPPs, or any other pertinent information.

References for this Document

EPA's Elements of Systematic Planning for Data Quality Assurance
http://www.epa.gov/quality/epas-elements-systematic-planning-data-quality-assurance

EPA Quality Manual for Environmental Programs – CIO 215-P-01-0 – May 2000
http://www.epa.gov/sites/production/files/2015-09/documents/cio_2105-p-01-0.pdf

Natural Resources Conservation Service National Water Quality Handbook (2003)
http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044775.pdf

Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program Field Audit Requirements (February 2016)

Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program Manual of Standard Operating Procedures for Sample Collection and Analysis (February 2015) http://deq.wyoming.gov/wqd/qaqc/resources/manual/

Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program Quality Assurance Program Plan for Water Quality Monitoring (March 2016) http://deq.wyoming.gov/wqd/qaqc/resources/qapp/

Wyoming's Methods for Determining Surface Water Quality Condition and TMDL Prioritization (WDEQ, April 2014) http://deq.wyoming.gov/wqd/water-quality-assessment/resources/guidance/

Appendices for this Document

A. SAP Criteria

B. Example SAP

APPENDIX A - SAP Requirements

Required Item
Site Location Information (latitude, longitude and map) provided, and is consistent with the goals and design of the study?
Overall Study Design provided?
Water Quality Parameters delineated?
Sampling Duration and Frequency provided, and are consistent with the goals and design of the study?
Sample Collection and Analytical Methods provided, and are consistent with the goals and design of the study?
Quality Assurance Project Plan (QAPP) provided or cited?
Documentation indicating that the entity has obtained permission to sample study sites on State, National Park Service and private lands?
Documentation included indicating have **access** to sample sites on State, National Park Service and private lands?
Documentation included indicating the training and qualifications of samplers and data interpreters?
Title Page/Signature Approval Sheet/Table of Contents included?
Background/Site History included?
Specific Water Quality Concerns/Purpose Statement provided?
Corrective Actions described?
Credible Data Legislation Statement included?
Objectives stated?
Data Forms included?
Field Notes--description includes names of samplers, date and time, weather conditions, general observations of environment, notes on working condition of equipment, notes and justification on the need to modify any aspect of the Sampling and Analysis Plan (SAP) or a specific Standard Operating Procedure (SOP)?
Chain of Custody Information included?
Quality Assurance Quality Control (QAQC) report described?
Blank and duplicate data/Acceptable duplicate variability provided?
Description of instruments/equipment used, meter calibration logs, and equipment manuals included?
QA and Data Quality Objectives (DQOs) and reconciliation described?
Stated acceptance of field audits included?
Analytical procedures described?
Holding times listed?
Sample preservation described?
Sample containers/labeling described?
Number of spikes/Acceptable spike variability described?
Evaluation of data with historic or expected data described?
Description of how data will be reported and qualified included?

APPENDIX B – Example SAP

EXAMPLE ONLY
Sample and Analysis Plan For *Escherichia coli* Monitoring in the Longmire Creek Watershed 2016-2017

Absaroka County[1] Conservation District
Contact Person: Jane Doe
jane.doe@accd.org
123 Main Street
Durant, WY
307-555-1234

March 2016

[1]All names used under Copyright Law Fair Use Provision (17 U.S.C. § 107.) This note serves the entire document.

Table of Contents

List of Tables

1. Signature Page

Signature/Date:		
Name:	Jane Doe	
Title/Organization:	Primary Sampler	Absaroka County Conservation District

Signature/Date:		
Name:	John Doe	
Title/Organization:	Board Chairman	Absaroka County Conservation District

Signature/Date:		
Name:	Dr. Joseph Doe	
Title/Organization:	Lab Supervisor	Absaroka County Analytical Laboratory

Signature/Date:		
Name:	Jessica Doe	
Title/Organization:	QA Officer	WY DEQ/Water Quality Division

2. Introduction

This Sampling and Analysis Plan (SAP) is intended to serve three primary purposes. First, it should be used as a field guide for personnel conducting water quality sampling and monitoring within the project area. Second, this document serves as a data management plan. Finally, this document fulfills the requirements of Wyoming Statutes (W.S.) 35-11-303 (c) (xix), and 35-11-302 (b) (i) and (ii), commonly known as the Credible Data Legislation.

Samples are to be collected according to the methods, procedures and protocols found in the Natural Resources Conservation Service *National Handbook of Water Quality Monitoring* (2003), and the Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program *Manual of Standard Operating Procedures for Sample Collection and Analysis*, February 2015 (WDEQ SOP Manual). These documents are incorporated by reference in this Sampling and Analysis Plan.

One stream within the Longmire Creek Watershed has been identified by WDEQ as having water quality impairments associated with elevated levels of *Escherichia coli* bacteria. This stream, Starbuck Creek, is located within the Kady Mountain Unit of the Standing Bear National Forest (SBNF). The stream is currently included on the WDEQ 303(d) List of Waters Requiring TMDLs (WDEQ 2012). The Absaroka County Conservation District (ACCD) initiated watershed planning efforts in 2004 and has since conducted annual water quality monitoring to better understand factors influencing the impaired reaches and to monitor each streams trends in bacteria levels.

Sampling during the 2016-2017 monitoring seasons will measure *E. coli* and field parameters at the same sites used in previous years, to allow direct comparison of data. The sites were originally chosen to be able to measure the effects of Best Management Practices (BMPs) on the watershed.

3. Quality Assurance Project Plan (QAPP)

This Sampling and Analysis incorporates by reference the Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program Monitoring Quality Assurance Project Plan (QAPP), 2016 The QAPP has been read and understood by all persons listed in Section 6.1 below. A copy of the QAPP is kept at the ACCD office.

4. Background/Site History

The Longmire Creek Watershed is located in north-central Wyoming and originates in the mountains west of Durant, Wyoming. It encompasses 67,520 acres (118 square miles) within Absaroka County, including the residential area of Durant, several rural subdivisions, numerous ranches, and a section of the SBNF. Ownership within this watershed consists of: 15,000 acres of SBNF lands which is managed for recreation, seasonal cattle grazing, logging, and wildlife; 36,700 acres of privately owned lands where a majority are small and large ranch operations; the remaining 15,820 acres are State, County or other Federal lands. Ranching operations within the Longmire Creek Watershed contain irrigated hay and crop lands, as well as pastureland for cattle grazing and corrals for feeding. In rural residential/small acreage

areas, there may be more horses and domestic animals than cattle. Big game, waterfowl, and other wildlife habitats can also be found on privately owned lands. The density of rural housing generally increases from the mountain foothills downstream to Durant. North and downstream of Durant, agriculture again becomes the dominant land use.

One stream within the Longmire Creek Watershed has been identified by the WDEQ as having water quality impairments associated with elevated levels of *E. coli* bacteria. This stream, Starbuck Creek, is located partially within the Kady Mountain Unit of the SBNF. The segment of the stream closest to the confluence with Longmire Creek is currently included on the WDEQ 303(d) List of Waters Requiring TMDLs (WDEQ 2012). The ACCD initiated watershed planning efforts in 2004 and has since conducted annual water quality monitoring to better understand factors influencing the impaired reaches and to monitor each streams trends in bacteria levels.

ACCD works jointly with the United States Forest Service (USFS) and the Kady Mountain Grazing Association (KMGA) when addressing water quality concerns and watershed management issues/objectives within the Longmire Creek basin. More information regarding water quality monitoring activities, watershed planning efforts and the implementation of (BMPs) can be obtained in both the annual USFS Water Quality Action Plans (USFS 2004-2014) and the Kady Mountain Annual Water Quality Data Reports (ACCD 2004-2014).

Water quality impairments within the Longmire Creek drainage were initially identified by the WDEQ in the 2004 Integrated 305(b) Report and Starbuck Creek was subsequently included on the 2004 303(d) list of impaired water bodies within the state. Extensive data collected by the ACCD during 2004-2007 indicated that the stream was meeting the water quality standards for its designated uses resulting in the stream being removed from the 303(d) list in 2008. High bacteria samples in 2009 again caused the stream to be included on the 2010 303(d) list, where it has remained since then. During the fall of 2014, ACCD was notified by WDEQ staff that they intended to move forward with a TMDL on Starbuck Creek beginning in early 2017. After several meetings with DEQ staff, ACCD decided to continue monitoring *E. coli* bacteria levels on the Starbuck Creek in 2016 to provide supplemental data in advance of TMDL development.

5. Purpose and Objectives

Impairment of streams within Absaroka County is of great concern to the ACCD. Since the source of impairment on the listed stream is unknown, the ACCD will continue water monitoring efforts to identify potential contributors and assess the effectiveness of BMPs. The ACCD will also cooperate with WDEQ to collaborate on monitoring efforts on the lower end of Starbuck Creek and its confluence with Longmire Creek. This collaborative effort will allow both entities to better understand the bacteria impairment as it moves through Starbuck Creek as well as identify contributors and possible solutions through the use of BMPs.

Objectives:

- To provide supplemental data on the *E. coli* impairment on Starbuck Creek in advance of TMDL development.
- To evaluate the effect of BMPs on *E. coli* loads in the Longmire Creek Watershed.

6. Study Design

The sampling design is based on previous monitoring conducted by ACCD to assess *E.coli* and gather data to determine trends in the watershed. Additionally, the parameters sampled and measured in combination with the *E.coli* sampling will provide the ACCD and WDEQ an understanding of overall water quality within each stream, help determine if the streams are meeting their designated uses, and help measure BMP impact. The ACCD will cooperate with the WDEQ to collaborate on monitoring efforts on the lower end of Starbuck Creek and its confluence with Longmire Creek. This collaborative effort will allow both entities to better understand the bacteria impairment as it moves through Starbuck Creek as well as identify contributors and possible solutions through the use of BMPs.

6.1.Personnel

ACCD currently employs two full-time people who act as samplers and data interpreters. Field sampling is always completed by a two person crew.

Table 1 Sampling and Data Interpretation Personnel

Name	Title	Training and Qualifications/Date	Experience
Jane Doe	Project Manager, Primary Sampler, Data Interpreter	B.S. Microbiology, UW - 2004	8 years monitoring with ACCD
		WACD Modules I, II, III - 2008	
		WACD Recertification - 2012	
Annie Minion	Secondary Sampler	WACD Modules I, II, III - 2014	2 years monitoring with ACCD

6.2.Site Location/Permission

A Garmin GPS unit was used to determine latitude and longitude coordinates for each monitoring site. Written permission from landowners has been obtained for sampling monitoring sites located on private and State lands as well as permission to transit such land on the way to each monitoring site. ACCD will also notify each landowner before each site visit to or across their property. The ACCD takes landowner permission and privacy seriously. Proof of the landowner agreements obtained by ACCD can be viewed at the ACCD office. A list of sample sites, latitude/ longitude coordinates for each site, and a description of each site are presented in Table 2 below. Maps of the route ACCD takes to access each site is located

in Appendix A. All the sites were chosen based on previous monitoring project site locations to make evaluation with historical data straightforward.

Table 2 Site Location

Site ID	Waterbody Name	Latitude/Longitude	Land Ownership	Directions
LC-1	Longmire Creek at North Bridge	43.7322, -108.4677	Private	3.1 mi N of Durant Town Hall (Hwy 192) on Hwy 29
LC-2	Longmire Creek at South Bridge	43.7244, -108.4610	Private	2.3 mi N of Durant Town Hall (Hwy 192) on Hwy 29
SBC-1	Standing Bear Creek	43.7298, -108.4612	Private	3.8 mi N of Hwy 192 on CR 37
SC-1	Starbuck Creek	43.7286, -108.4688	State	3.3 mi N of Absaroka County water treatment facility (Hwy 192) on CR 41

6.3.Water Quality Parameters

The primary water quality parameter collected under this SAP is *E. coli* bacteria concentrations. Turbidity is generally collected at the same time as bacteria samples to obtain more information regarding stream characteristics. Additional parameters such as streamflow, pH, conductivity, and temperature are collected as supplemental data. (See **Table 3** on the following page.)

Table 3 Water Quality Parameters

Parameters [Units]	Chemistry/ Field Test Method	Preservative	Holding Time	Container
***E. coli* & total coliform** [Most Probable Number (MPN) # of colony forming units (cfu) / 100 milliliters (ml)]	IDEXX Colilert®-Defined Enzyme Substrate Method WDEQ SOP Manual (2015) pp. 59-68	Iced < 10° C, Sodium thiosulfate for de-chlorination	8 hours	Sterile Whirl-pak™ Bags (100ml)
Temperature (°C) **pH** (S.U.) **Conductivity** (µS/cm)	Hanna Instruments HI991300 Manual	n/a	n/a	Bucket
Discharge/Stream Flow – cubic feet per second (CFS)	Marsh-McBirney Flo-Mate 2000 Flow Meter Manual	n/a	n/a	Measured *in situ*
Turbidity (NTU)	HACH 2100P Turbidimeter Manual	n/a	n/a	Glass vial

6.4. Field Instruments and Calibration Logs

The calibration of the Hanna Portable HI991300 Meter will be conducted using standard pH 7 and pH 10 buffer solutions for the two point calibration method. Specific conductivity will be checked using a standard solution (1413 µS) on a biweekly basis. Calibration standards are usually purchased from either BB8 Fluid Flow Solutions located in Millennium Springs, Colorado (800-555-5678) or Ben Mountains located in Cheeseville, Wisconsin (800-555-6789). Standards are replaced before their expiration date. Maintenance on all equipment is the responsibility of the primary sampler and will be conducted as recommended in the equipment manuals. All equipment will be calibrated according to the manufacturers' recommendations. A copy of the calibration form is included in **Appendix B**. Manuals will also be kept with the equipment for field use.

Table 4 Field Equipment

Item	Calibration	Maintenance	SOP or Method
Hanna multi probe HI991300 SN: 001122	pH 7 and pH 10 conductivity – 1413 µS/cm	prior to monitoring, at least biweekly	WDEQ SOP Manual 2015 pp. 171-172 WDEQ SOP Manual 2015 pp. 161
http://www.hannainst.com.au/manuals/manHI_991300_01.pdf			
HACH 2100P Turbidimeter SN: 0102030405	<0.1, 20, 100 and 800 NTU	at least every 3 months	WDEQ SOP Manual 2015 pp. 179-180
http://www.hach.com/2100p-portable-turbidimeter/product-downloads?id=7640450099			
Marsh-McBirney Flow-Mate 2000 flow meter SN: 123456	Still bucket of water	Prior to beginning of each season	WDEQ SOP Manual 2015 pp. 137-140
http://www.hachflow.com/pdf/Model_2000_Manual.pdf			
Quanti-Tray Sealer Model 2X SN: 123456	N/A	Prompt cleaning of spills; otherwise refer to IDEXX Service Center	WDEQ SOP Manual 2015 pp. 63-68
https://www.idexx.com/resource-library/water/quanti-tray-sealer-2x-maintenance-instructions-en.pdf			
BINDER Incubator Model BD 23 SN: 123456	N/A	Prompt cleaning of spills; otherwise refer to BINDER GmbH	WDEQ SOP Manual 2015 pp. 63-68
https://us.vwr.com/store/asset?assetURI=https://us.vwr.com/stibo/hi_res/std.lang.all/43/22/15134322.pdf			

6.5.Sample Duration and Frequency

Sampling will occur May 1 – September 30 (to coincide with the primary contact recreation season) in both 2016 and 2017. All parameters will be sampled at all sites on a bi-weekly schedule, following *Wyoming's Methods for Determining Surface Water Quality Condition and TMDL Prioritization (WDEQ 2014),* which requires that *E. coli* samples be collected five (5) times within a 60-day period, with the collection dates at least 10 days apart, and the results used to calculate a geometric mean.

6.6.Sample Collection and Analytical Methods

ACCD will utilize the SOPs in **Table 5** for sample collection and analytic methods. All SOPs originate from and are page referenced to the WDEQ SOP Manual.

Table 5 Standard Operating Procedure (SOP) References

Topic	SOP Title	SOP Pages
Aseptic Technique	**Aseptic Technique**	189
E. coli	**Coliform Bacteria Sampling** (Whirl-Pak sampling)	59-62
E. coli	***Escherichia coli* & Total Coliform Bacteria** Colilert®-Defined Enzyme Substrate Method	63-68
Geometric Mean	**Geometric Mean, Calculating and Using**	75-77
Flow/Stream Discharge	**Stream Discharge** – Wadeable Streams and Rivers	137-140
Conductivity	**Conductance, Specific Conductivity**	161
pH	**pH**	171-172
Temperature	**Temperature, Water**	177
Turbidity	**Turbidity**	179-180
Blanks	**Blanks**	192-194
Chain of Custody	**Chain of Custody**	197-203
Duplicates	**Duplicates**	223-224
Precision	**Precision (Field Duplicates)**	238-239
Quality Control	**Quality Control Measures**	240-243
Sample Collection	**Sample Collection**	246-247
Temperature Blank	**Temperature Blank**	280
Field Log Books	**Field Log Books**	227-228
Instrument Calibrations	**Instrument Calibrations and Calibration Logs**	230-231
Quality Control	**Quality Control Measures, Summary of**	239-242
Safety and Safety Equipment	**Safety and Safety Equipment**	244
Sample Labeling	**Sample Labeling**	245-246
Waste Disposal	**Waste Disposal**	278

6.7.Sample Containers and Labeling

Bacterial samples (*E. coli*) will be collected using sterile 4 oz/120 mL Whirl-Pak™ bags purchased from IDEXX. Samples are labeled in the field at the sampling location. Labeling procedure will follow *Wyoming Department of Environmental Quality, Water Quality Division, Watershed Program Manual of*

Standard Operating Procedures for Sample Collection and Analysis, February 2015, Sample Labeling, p. 248. An example label is provided in Appendix C. Turbidity is measured using a glass vial supplied with the turbidimeter, and does not require labeling as the measurement is done at the site.

6.8. Field Notes

Field notes will follow the WDEQ SOP Manual, SOP for Field Log Books, pp. 228-229, and will include the sampler's name, the date and time of sample collection, weather conditions, environmental conditions, notes on any equipment issues, and any modifications made to the SAP or SOPs.

Field Data Sheets from the WDEQ SOP Manual will be filled out as presented in Appendix B.

6.9. Corrective Actions

Project evaluation will regularly occur during the 2016-2017 *E. coli* sampling in the Longmire Creek watershed. Any need for modification in this Sampling and Analysis Plan, including site locations and schedule, number of samples per site, number of sites, sampling forms, calibration logs, laboratory choice, number or type of quality control samples, sampling methods or standard operating procedures, methods for determining surface water quality condition or database application will be decided concurrently by the ACCD employees/field personnel and the ACCD Board of Supervisors. Records, such as field personnel/training, which may be subject to change during the course of the project, will be updated as necessary. If any change in the structure of the monitoring plan is needed, the project manager will insert the dated amendment in the SAP. The project manager will also notify all field and WDEQ personnel of amendments to the SAP. Following any changes made, the project manager will assess the effects of the changes.

Field personnel are responsible for performing immediate corrective action in the field if a QC issue is found during field QC checks; typically this corrective action will involve instrument maintenance, recalibration, or re-sampling. Field personnel will document this type of corrective action in the field notes. If quality control samples are not meeting project criteria or if any other event requires corrective action, ACCD personnel will follow the procedures in the WDEQ SOP Manual, SOP for Quality Control Measures, Summary of, pp. 240-243, for assessment and response actions.

6.10. Safety

The health and safety of all members of the ACCD field crew will remain the highest priority during the project. Protocols for sampling and safety will follow the WDEQ SOP Manual, SOP for Safety and Safety Equipment, p. 245, and emergency and evacuation plans will be discussed prior to each season. ACCD staff will wear protective latex or nitrile gloves during sample collection and processing to reduce the risk of exposure to certain pathogens, and germicidal hand sanitizer will be available in the truck. Postponing sampling may be necessary during extreme conditions. The crew will carry a cellular phone to remote sites as an added precaution.

Nearest Hospital: Durant Medical Center
640 Red Pony Rd.

Durant, WY
(307) 555-2424

6.11. Laboratory

ACCD will send duplicate *E. coli* samples to the ABC Water Quality Laboratory twice during each sampling season for an independent analysis. The ABC Water Quality Laboratory QAPP has been reviewed by the samplers and is stored in the ACCD office.

ABC Water Quality Laboratory
123 Main St.
Anywhere, WY 82002
Phone: (555) 123-4567
E-mail: intake@abc_lab.org

Laboratory Results: ABC Water Quality Laboratory scans the lab data sheets and e-mails the file to ACCD. The original data sheets are kept by the Lab. ACCD reviews the electronic data sheets, print hard copies for files and stores an electronic copy on the ACCD server.

7. QA/QC

Quality Assurance is a part of the research and planning which goes into the study design. Quality control is achieved and maintained when all persons collecting data follow SOPs so that sample collection, chain of custody, data entry, sample handling and sample processing are consistent from one sampler and/or location to another. Water Quality Division or commercial laboratory analytical methods follow USEPA approved test protocols with quality control parameters listed in each method. Contract laboratory methods are determined to be either comparable to or USEPA approved before samples are submitted for analysis. Documenting quality control allows users of the data to determine the quality of a given data set, as well as determine whether different methods produce data of comparable quality.

7.1.Chain of Custody

Forms provided by the ABC Water Quality Laboratory serve as chain of custody forms. The forms include sample ID, collection date and time, parameters to be analyzed, preservatives used, and the signature of the sampler. Employees of each lab record the date and time when the sample is received and the temperature of the sample and assign the sample a lab ID. Hard copies of these records remain in the laboratory office and a copy is sent electronically to the ACCD office. These records are kept electronically and backed up weekly in addition to printed copies that are kept in a notebook at the ACCD office. The Chain of Custody form is included in **Appendix B**.

7.2.Data Quality Objectives (DQOs)

Data quality objectives (DQOs) are qualitative and quantitative statements derived from the systematic planning process that specify the level of uncertainty that decision makers are willing to accept in the collected monitoring data while still meeting the project objectives. Measurement performance criteria are expressed in terms of Data Quality Indicators (DQIs) which include precision, accuracy, and completeness.

Table 6 Data Quality Indicators

Parameter	Precision	Accuracy	Completeness	Method Reference
Water Quality Metrics	Defined as Relative Percent Difference of duplicates	Defined under specifications in manufacturer's instrument manual		
Temperature	± 10%	±0.5°C / ±1°F (Hanna multi probe HI991300)	95%	170.1; EPA 1983
pH	± 0.3 S.U.	±0.01 pH (Hanna multi probe HI991300)	95%	150.1; EPA 1983
Conductivity	± 10%	±2% F.S. (EC/TDS) (Hanna multi probe HI991300)	95%	120.1; EPA 1983
Turbidity	± 20% *	± 2% of reading plus stray light from 0-1000 NTU (Hach Model 2100P, Portable Turbidimeter)	95%	180.1; EPA 1983
E. coli	± 50% **	***	95%	WDEQ SOP Manual 2015
Flow/Discharge	NA	NA	95%	WDEQ SOP Manual 2015

* For results > 10 times the reporting limit

** For MPN > 100 cfu/100 ml

*** Duplicate counts of the number of positive wells identified from a Quanti-Tray® sample between analysts should agree within 10%

Accuracy is a measure of the overall agreement of a measurement to a known value such as a reference or standard. It includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations. Field instruments are calibrated, maintained, and checked against standard reference materials (SRMs) to ensure accurate measurement of water quality parameters. Additionally, accuracy is improved in the field through the use of and adherence to SOPs.

Precision is the measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions; expressed as the relative percent difference (RPD). Overall precision for sampling and analysis is assessed via field duplicates/replicates – co-located simultaneous or consecutive samples are collected, processed, and analyzed to obtain information on sample

acquisition, handling, shipping, storage preparation, and analytical processes and measurements. In the field, precision is maximized (variability is reduced) through strict adherence to SOPs for sampling methods and sample handling.

Completeness is a measure of the amount of valid data obtained from a monitoring program/project compared to the amount of valid data expected to be obtained. Completeness is calculated by dividing the number of valid measurements completed (samples collected and/or analyzed) by the total number of measurements planned for the project's dataset and is expressed as a percentage.

7.3.Blanks and Duplicates

Blanks and duplicates will be collected for quality control purposes and their collection will be conducted according to the WDEQ SOP Manual, SOPs for Blanks, Duplicates, Coliform Bacteria Sampling, and Temperature Blanks. Field parameter duplicates will be collected for 10% of the samples collected throughout each sampling season.

Table 7 Blank and Duplicate Collection for *E. coli*

Sample Site ID	Type of QC Sample	Number or % of QC Sample	QC Sample Schedule
In sequence with other samples	Duplicate	1 per sampling day or 10% of the samples per day if more than 10 are collected	Alternate among sample locations
"Field Blank"	Field Blank	1 per trip	Throughout the monitoring season
"Temperature Blank"	Temperature Blank	1 per trip	Throughout the monitoring season
"Lab Blank"	Lab Blank	1 per batch of samples run	Throughout the monitoring season

7.4.Field Audits

If requested, ACCD will work with the WDEQ QA/QC officer or other third-party entity to complete a field audit.

8. Analysis

ACCD will analyze the data collected during this project to identify potential contributors and assess the effectiveness of BMPs implemented by the USFS and the KMGA in cooperation with ACCD.

8.1. Analytical Procedures

Data analysis will involve calculation of geometric means according to the WDEQ SOP Manual, SOP for Calculating and Using Geometric Means pp. 75-77. The detection limit using Colilert is <1 cfu/100ml. When data results in <1 cfu/100ml, a value of 1 cfu/100 ml will be used for calculating the geometric

mean. When data results are >2419.6 cfu/100ml, a value of 2419.6 cfu/100 ml will be used for collecting the geometric mean. Data analysis and reports will be provided to participating entities after completion of a final report. Analysis and reports will be completed after the 2017 sampling season has ended.

8.2. Reconciliation with DQOs

After data analysis, the ACCD project manager will determine whether or not the data quality objectives of this project were met. The project data gathered will be compared to the list of data quality objectives. If the data quality objectives were not met, the possible reasons will be listed and the project manager will decide whether the data should be qualified or rejected.

The ACCD project manager, along with the ACCD Board of Supervisors, will examine the initial list of project objectives. If any of the project objectives were not met, the reviewers will decide whether the objectives should be altered for future monitoring, or if other changes can be made to ensure all objectives are reached in the future. The ACCD project manager will document the data quality objectives and project objectives review, conclusions, and any changes in objectives that may be made.

8.3.Evaluation of Data

Data will be evaluated with available historic data from previous ACCD monitoring studies. Results of this evaluation will be included in the final data report.

9. Data Verification and Validation

The ACCD project manager will perform the following data verification and validation procedures:

- Review the data to make sure all forms were filled out correctly and completely, including Field Log Books, Laboratory Data Sheets, *E. coli* analysis logs, Field Data Sheets, and equipment calibration logs.
- Verify holding times, techniques, duplicates, and blanks were conducted according to the methods outlined in the WDEQ SOP Manual and this SAP.
- Examine the raw data and verify geometric mean calculations by reviewing spreadsheet formulas utilized for geometric mean calculation.
- Examine data to verify that raw data is accurately transcribed for data management and storage.
- Review data to ensure that the WDEQ SOP Manual SOPs for Precision/Accuracy objectives for each parameter are being met. This includes ensuring all *E. coli* duplicate pairs have an RPD less than 50% if the Most Probable Number (MPN) is >100.

The ACCD project manager will review the water quality data at the end of each sampling season to look for consistency, completeness, and accuracy of the data records.

9.1. Reporting and Qualifying Data

Data validation is the process which determines whether data collection quality control (QC) objectives were met. The end result of the data validation process for each data set will be a decision by the project manager to accept the data unconditionally, to qualify the data set, or to reject it. Data which are rejected will not be used at all. Data which may or may not be useable are qualified, and the reasons for the qualification are given so that project manager, with assistance from WDEQ, can evaluate its suitability. Data Validation also includes a decision by the project manager about the usability of data which does not meet project-specific data criteria.

10. Data Archival

The original paper format of all field data sheets that includes sampled parameters with the appropriate units and the numerical result for each parameter (pH, temperature, conductivity, turbidity, flow, and *E. coli*) will be archived by the project manager in their original paper format at the ACCD office in Durant. Calibration logs are permanently archived at the ACCD office in their original (paper) format.

All project results will be entered by the project manager into a Hewlett-Packard computer with Microsoft Office programs (i.e. Excel, Access, and Word) or equivalent computer and/or software. All files will be saved on the hard drive of the computer, and a backup copy will be made of every data file, graphic interpretation, and related project report each day data is entered or edited. Computer files and backup copies will be kept at ACCD permanently, along with the original paper copies of all monitoring results. The ACCD project manager will be responsible for all original paper and electronic copies of project data forms, chain of custody forms, calibration logs, field log books, project data and reports, maps and photographs of sampling sites, and other related files archived at the ACCD office. The ACCD Project Manager will use project results to generate a final report to submit to the WDEQ-Water Quality Division (WQD).

11. Reports

After the data have been reviewed and analyzed, a final report will be completed by the project manager. The report will serve to summarize the water quality data and to serve as a method for sharing the data with involved agencies, individuals, watershed steering committee members, and the general public. The final data report includes raw data, a summary of the QA/QC activities, calculated geometric means, a narrative of the water quality results, a brief summary of the monitoring efforts, and an evaluation and comparison of the data with historic or expected data. The final data report will also address analytical deficiencies and field QC non-compliance. This final data report will serve as the data verification and validation report.

References

Natural Resources Conservation Service National Water Quality Handbook (2003)

Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program Manual of Standard Operating Procedures for Sample Collection and Analysis (February 2015)

Wyoming Department of Environmental Quality, Water Quality Division, Watershed Protection Program Quality Assurance Program Plan For Water Quality Monitoring (March 2016)

Wyoming's Methods for Determining Surface Water Quality Condition and TMDL Prioritization (WDEQ, April 2014)

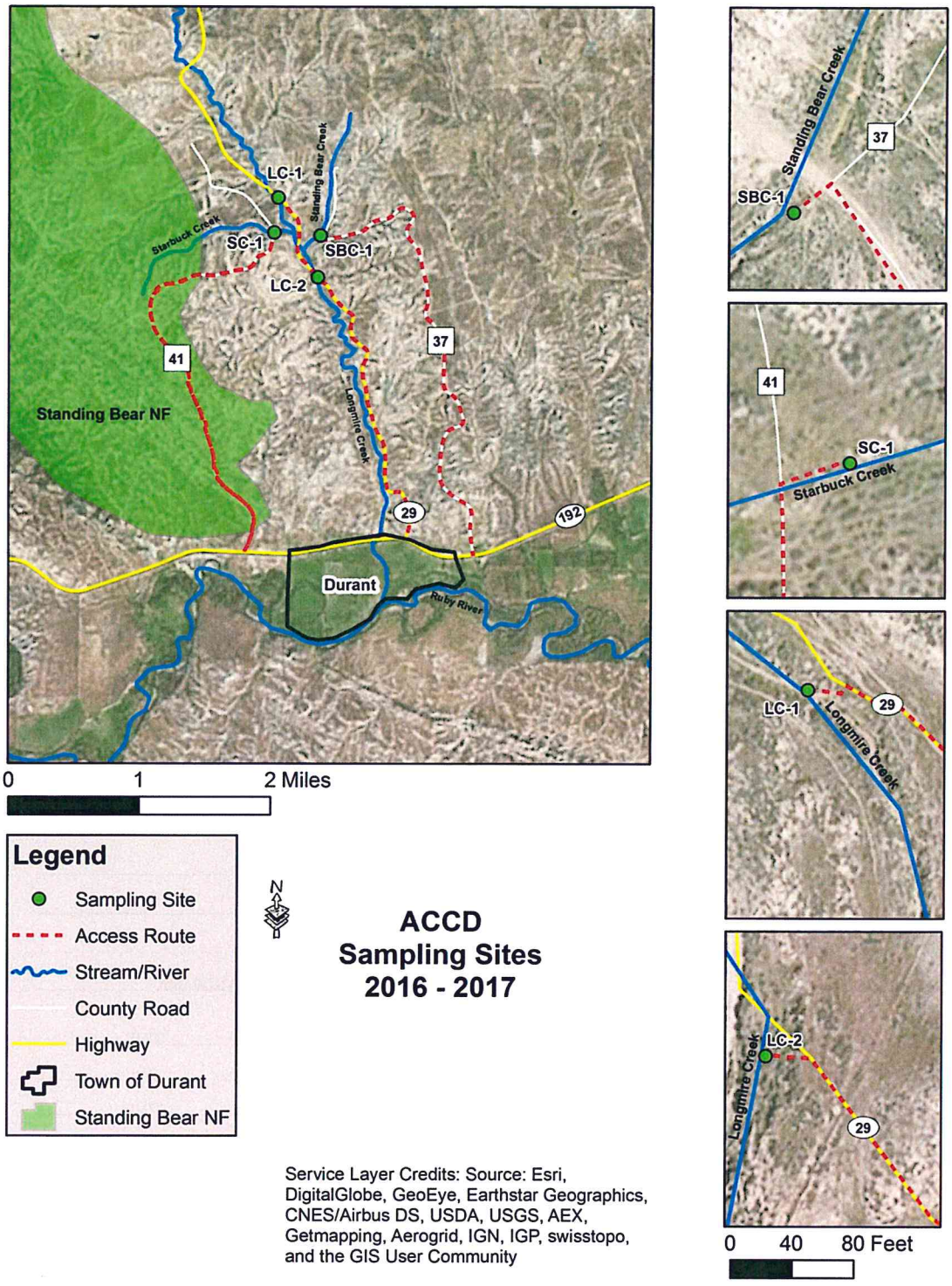
Appendices

Appendix A – Maps (Location and Access Routes)

Appendix B – Forms

Appendix C – Sample Label

Appendix A – Map and Access Routes



Appendix B – Forms

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
WADEABLE STREAMS ASSESSMENT FIELD DATA FORM

REACH DESCRIPTION (Complete Bold and Underlined Entries in Field)

DATE (mm-dd-yyyy) __ __ - __ __ - __ __ __ __ DEQ ID CODE __ __ __ __ __ __ __ MAJOR BASIN_____

STREAM NAME _____ **REACH NAME** _____

SAMPLING PURPOSE/PROJECT: Reference Random Targeted Spill/Complaint Other_____

DATA COLLECTORS (and initials) _____
Note: List all observers by name in the Field Notes.

HUC CODE __ __ __ __ __ __ __ __ __ __ __ __ DEQ STREAM CLASSIFICATION: 1 2 2_{ww} 3 4 AB A B C D
Class Subcategory

ECOREGION: Level III_____ Level IV_____ ORDER: 1 2 3 4 5 6

USGS MAP (1:24K) _____ BLM MAP (1:100K) _____

COUNTY _____ COORDINATES ___1/4___1/4 SEC___ ___ T___ ___N R___ ___ ___W

GPS FILE _____ **LATITUDE** __ __ . __ __ __ __ __ __ __ __ **LONGITUDE** __ __ __ . __ __ __ __ __ __ __ __

ELEVATION _____ ft DRAINAGE AREA _____ mi^2 **LANDFORM (Circle one):** Mountain Foothills Plains

LAND STATUS (Circle one): Private State County Municipal Military Tribal USFS BLM USFWS NPS DOE BOR

CONTACT _____ PHONE (_____) _____ - _____

ADDRESS _____

RESULTS REQUESTED? Y N Notes: _____

DIRECTIONS TO REACH: _____

_____

_____

_____

_____

_____

PHOTOS (Record number and time taken) **PHOTOGRAPHER** _____

UPSTREAM (from base of riffle) _____ **DOWNSTREAM (from top of riffle)** _____ **PANORAMA** _____

OTHER PHOTOS:
1. CAPTION _____ TIME_____
2. CAPTION _____ TIME_____
3. CAPTION _____ TIME_____
4. CAPTION _____ TIME_____
5. CAPTION _____ TIME_____

Continue in Field Notes, if necessary.

Stream Name_____ Reach Name_____

WATER SAMPLE COLLECTION

DATE (mm-dd-yyyy) __ __ - __ __ - __ __ __ __ TIME_____ SAMPLE ID __ __ __ - __ __ - __ __ __ - __
(Initials) - (Year) - (J. day) - (No.)

QA DUPLICATE? Y N DUPL. SITE NAME _____ DUPL. SAMPLE ID __ __ __ - __ __ - __ __ __ - __

TRIP BLANK SAMPLE ID __ __ __ - __ __ - __ __ __ - __ FIELD BLANK SAMPLE ID __ __ __ - __ __ - __ __ __ - __

SAMPLED BY (Name and Organization) _____ WEATHER_____

PARAMETER	CONTAINER	PRESERVATIVE	PRESERVED
[TSS] [Alkalinity] [Chloride] [Sulfate] [TDS]	☐ 1000 mL P ☐ Other_____	Iced	Y N
[Total Kjeldahl Nitrogen (TKN)] [Nitrate+Nitrite (NO_3+NO_2)] [Total Nitrogen (TN)] [Total Phosphorus (TP)]	☐ 500 mL P ☐ Other_____	1+1 H_2SO_4; Iced	Y N
[Hardness], [Dis. As], [Dis. Zn], [Dis. Cd] [Dis Fe] [Dis K], [Dis Mn], [Dis Na], [Dis Al]	☐ 250 mL P ☐ Other_____	Filtered; 1+1 HNO_3	Y N
[T. Se]	☐ 250 mL P ☐ Other_____	1+1 HNO_3	Y N

FIELD PARAMETERS	pH (SU)	TEMP (°C)	COND. (µS/cm)	DISSOLVED OXYGEN (mg/L) & (% sat)		TURBIDITY (NTU)		
Sample								
Duplicate								

INSTRUMENT CALIBRATION CHECK (Check performed before field measurements)

Instrument	Calibration Date[1]	Value of Check Standard	Measured Value of Check Standard	Notes
pH (SU)				
Sp. Cond. (µ S/cm @ 25°C)				
Dissolved Oxygen (% sat.)				
Turbidity (NTU)- Gelex Stnd.				

[1]Refer to field sampler's instrument calibration log book.

E. coli SAMPLE: DATE (mm-dd-yyyy) __ __ - __ __ - __ __ __ __ TIME_____ QA DUPLICATE? Y N

CONTAINER: IDEXX® Whirl-Pak® Other_____ VOLUME: 100 mL Other_____ mL

BLANK PREPARED? Y N TIME BLANK PREPARED_____ SAMPLES PRESERVED ON ICE? Y N

WATER SHEEN	SLIMES	COLOR	ODORS
☐ None	☐ None	☐ None	☐ None
☐ Intermittent	☐ Rare	☐ Brown	☐ Anaerobic
☐ Consistent	☐ Common	☐ Green	☐ Sewage
☐ Free Product	☐ Abundant	☐ Gray	☐ H_2S
		☐ Other_____	☐ Other_____

OTHER MATERIAL ON STREAMBED (iron or aluminum oxides, calcium carbonate, oil or organic sludge, other precipitate)

☐ None
☐ Slight
☐ Moderate
☐ Severe

If present, describe color_____

SALINIZATION

☐ None evident
☐ Evidence of salinity present in watershed, but none observed in or near stream
☐ Minor evidence of salts in or near stream
☐ Salt crusts common in or near stream or on stream banks

FIELD/LAB INSTRUMENTS USED (Include Model and Serial Numbers)

pH: _____ DISSOLVED OXYGEN: _____

TEMPERATURE: _____ TURBIDIMETER: _____

CONDUCTIVITY: _____ FLOW METER: _____

Absaroka County Conservation District

Total Coliform and *Escherichia coli* Analysis Log (Colilert® Media)

Incubator Brand/Model/Serial No.:	Incubator Temp. (C°) In: Out:

Analyzed By:	Analysis Date [m/d/y]:	Field Sampler:

Station or Sample Site Location [GPS, Narrative] / Analysis Information [blanks, duplicates, splits]	Sample Collection Date [m/d/y]	Sample Collection Time [24 Hour]	Lab Sample ID #	Quanti-Tray	Quanti-Tray/2000	Sample Volume [mL]	In Incubator		Out Incubator		24 Hr Incubation 35 ± 0.5 [Y/N]	# Positive Wells				MPN/100 ml [Refer to MPN Table]	
												Total Coliform [yellow]		*E. coli* (fluorescence)			
							Date [m/d/y]	Time [24 Hour]	Date [m/d/y]	Time [24 Hour]		# Large Wells	# Small Wells	# Large Wells	# Small Wells	Total Coliform	*E. coli*
Remarks and Analytical Notes:																	

ABC Water Quality Laboratory Chain of Custody and Analytical Request Record (revision date: 4-4-2012)

Program Name/Project Name:	Contact Name:	Page ___ of
Contact Address:	Contact Phone/Email:	Custody Seal Y / N
Comments:		Cooler Temperature:
		On Ice: Y / N

Sample Name	Sample ID	Date	Time	# Containers	Analysis Requested											For Laboratory Use Only
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
Preservation: 1=ice, 2=H2SO4, 3=HCL, 4=HNO3, 5=NaOH, 6=other _____, 7=other_____																

Custody Record MUST Be Signed	Relinquished by (name/date/time):	Received by (name/date/time):
	Relinquished by (name/date/time):	Received by Laboratory (name/date/time):

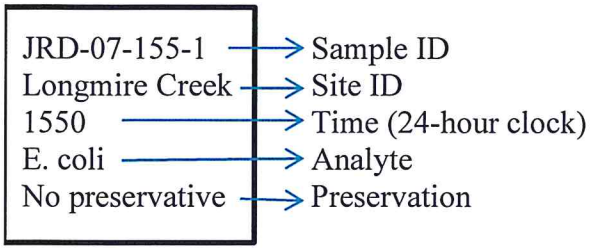
ACCD CALIBRATION LOG

Equipment (Make and Model #): _____ Serial Number _____

DATE	TIME	MAINTENANCE	STANDARD (LOT# AND EXPIRATION DATE)	COMMENT	STAFF

Appendix C – Example Label

Example Label:



Explanation of Sample ID

Sample ID #: JRD-07-155-1
JRD = Jane R. Doe (sampler)
07-155 = Julian Day equivalent to June 4, 2007
1 = first sample taken this day